dresden elektronik

User Manual
USB Radio Sticks

deRFusb-23E00
deRFusb-23E00 JTAG
deRFusb-23E06
deRFusb-23E06 JTAG
deRFusb-13E00
deRFusb-13E00 JTAG
deRFusb-13E06
deRFusb-13E06 JTAG

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Table of contents

1. Overview 6

2. Applications 7

3. Features 7

4. Assembling Options 9
   4.1. USB stick for 2.4 GHz application 9
   4.2. USB stick for Sub-GHz application 10

5. Technical data 11

6. Mechanical size 15

7. Application environment 16

8. Pin assignment 17

9. On-board transceiver 20
   9.1. General transceiver description 20
   9.2. Internal transceiver connection to the MCU 21

10. On-board components and peripherals 22
   10.1. Clock 22
   10.2. Programmable LEDs 22
   10.3. ERASE and VCC pins 23
   10.4. On-board flash (option) 23
      10.4.1. Mass Storage Device example 23
   10.5. Coaxial connector 26

11. Programming 27

12. Pre-flashed firmware 27
12.1. No firmware 27
12.2. Wireless UART firmware 27
12.2.1. Step-by-Step instructions for Windows 28
12.2.2. Step-by-Step instructions for Linux 29

13. Radio certification 30
13.1. United States (FCC) 30
13.2. European Union (ETSI) 31

14. Ordering information 33

15. Revision notes 35

16. References 35

Document history

Date	Version	Description
2011-06-29	1.0	Initial version
2011-07-01	1.1	Update - Certification 2.4 GHz USB radio stick, temperature range, radio data
2012-07-16	1.2	Update - Technical data, mechanical size, programming, certification information added - Options overview, application environment, programmable LEDs, clock, pre-flashed firmware, on-board flash, coaxial connector information added

Author / Check / Release

	Firm	Division / Name
Author	DE	Div. / APA
Check	DE	Div. / ML
Release		

Abbreviations

Abbreviation	Description
802.15.4	IEEE 802.15.4-standard, applicable to low-rate wireless Personal Area Network
ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
CE	(Applications) - Consumer Electronics
DAC	Digital to Analog Converter
DBGU	Debug Unit
eMMC	embedded Multimedia Card
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
GPIO	Generals Purpose Input Output
IC	(Certification) - Industry Canada
ISM	Industrial, Scientific and Medical frequency band
JTAG	Joint Test Action Group
MAC	Medium Access Control
MCU, µC	Microcontroller Unit
MMC	Multimedia Card
MSD	Mass Storage Device
PCB	Printed Circuit Board
PER	Packet Error Rate (measurement)
PWM	Pulse Width Modulation
RF	Radio Frequency
SPI	Serial Peripheral Interface
TRX	Transceiver
TWI	Two-Wire Serial Interface
UART	Universal Asynchronous Receiver Transmitter
U.FL	Miniature coaxial RF connector for high-frequency signals
USART	Universal Synchronous/Asynchronous Receiver Transmitter
USB	Universal Serial Bus
WPAN	Wireless Personal Area Network
WSN	Wireless Sensor Networks

1. Overview

The USB radio sticks by dresden elektronik provide access to the world of IEEE 802.15.4™ technology by being the gateway to almost any IEEE 802.15.4 Wireless Sensor Networks. Such gateways can be used for monitoring, sniffing or control of wireless ZigBee® or 6LoWPAN networks and are easily adoptable to custom applications due to the available free stack software.

The compact designed USB radio sticks deRFusb-23E00 and deRFusb-13E00 contain a powerful CORTEX-M3 microcontroller with 256 kB high-speed flash. Additional 2GB flash memory to store user defined data is provided using the USB radio sticks deRFusb-23E06 and deRFusb-13E06, it is usable as mass storage device.

Depending on the transmission frequency of 2.4 GHz - deRFusb-23E00/06/JTAG - or 868/915 MHz - deRFusb-13E00/06/JTAG - the ATMEL low-power transceivers AT86RF231 or alternatively AT86RF212 are integrated. They provide a complete radio transceiver interface between the antenna and the microcontroller and an extended functional range such as a 128-bit AES hardware engine to ensure data security.

For development the USB radio sticks provide a programming and debugging interface to the user, by default via native USB. For programming via JTAG, the board options deRFusb-23E00 JTAG, deRFusb-23E06 JTAG, deRFusb-13E00 JTAG and deRFusb-13E06 JTAG are advised.

2. Applications

The main applications for the USB radio sticks deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG are:

- 2.4 GHz and Sub-GHz range IEEE 802.15.4
- ZigBee Pro
- ZigBee RF4CE
- ZigBee IP
- 6LoWPAN
- ISA100.11a
- Wireless Sensor Networks (WSN)
- Industrial and home controlling and monitoring
- Gateway to other network technologies via PC or laptop

3. Features

The 2.4 GHz USB radio sticks deRFusb-23E00/JTAG and deRFusb-23E06/JTAG offer the following features:

- Compact size (in case): 71.0 x 23.0 x 8.7 mm
- USB powered
- 3 free programmable status LEDs (red, yellow, green)
- RF shielding
- Debugging/programming interfaces: 1 x DBGU and 1 x JTAG with 10-pin connector assembly option, native USB
- On-board transceiver and chip ceramic antenna 2.4 GHz
- Option: on-board 2 GB flash
- Certification: FCC certified, conformity ETSI/CE

The block diagram (**Figure 1**) below shows layout and interaction of the main deRFusb-23E00/06/JTAG components:

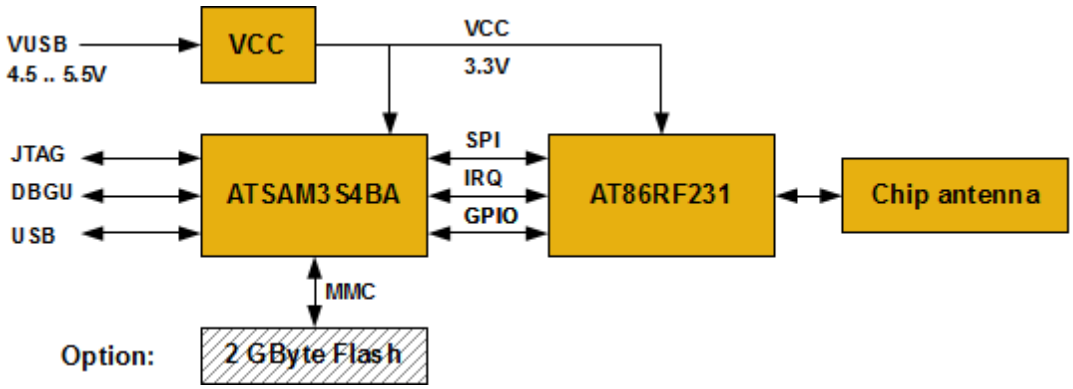


Figure 1: Block diagram deRFusb-23E00/06/JTAG

The Sub-GHz USB radio sticks deRFusb-13E00/JTAG and deRFusb-13E06/JTAG offer similar features:

- Compact size (in case): 71.0 x 23.0 x 8.7 mm
- USB powered
- 3 free programmable status LEDs (red, yellow, green)
- RF shielding
- Debugging/programming interfaces: 1 x DBGU and 1 x JTAG with 10-pin connector assembly option, native USB
- On-board transceiver and chip ceramic antenna Sub-GHz
- Option: on-board 2 GB flash
- Conformity ETSI/CE

Layout and interaction of the main deRFusb-13E00/06/JTAG components is shown in **Figure 2**.

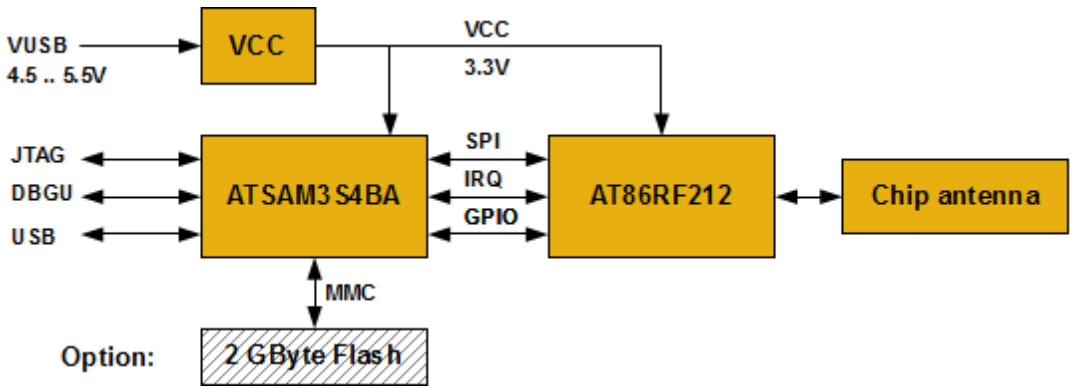


Figure 2: Block diagram deRFusb-13E00/06/JTAG

4. Assembling Options

This section gives a short overview of the different available USB stick options and their assembly parts.

The basic assembly and design options of the USB radio sticks are:

- 10-pin connector
- 2 GB flash

4.1. USB stick for 2.4 GHz application

The 2.4 GHz USB stick is available with an optional 10-pin connector and an optional 2 GB flash memory. In **Figure 3** and **Figure 4** the deRFusb-23E00 JTAG device is imaged. The RF shielding covers the microcontroller, the transceiver, the quartz crystals and all necessary passive components.

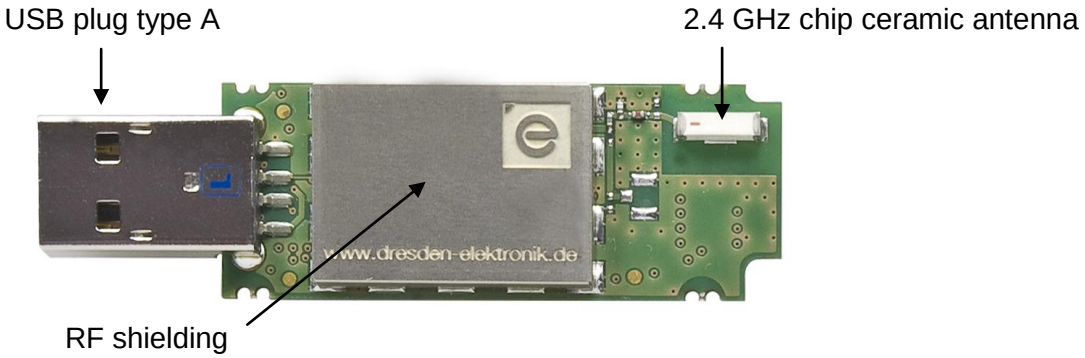


Figure 3: Top view deRFusb-23E00 JTAG

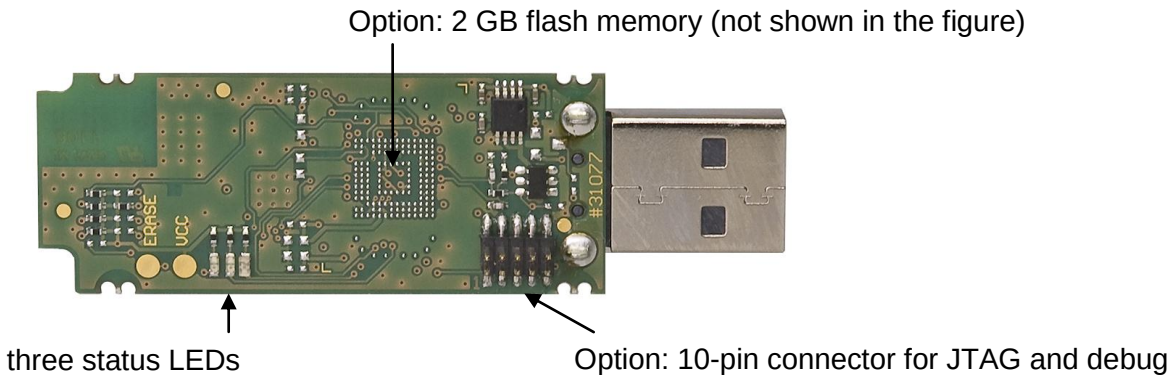


Figure 4: Bottom view deRFusb-23E00 JTAG

4.2. USB stick for Sub-GHz application

The Sub-GHz USB stick is available with an optional 10-pin connector and an optional 2 GB flash memory. In **Figure 5** and **Figure 6** the deRFusb-13E00 JTAG device is imaged. The RF shielding covers the microcontroller, the transceiver, the quartz crystals and all necessary passive components.

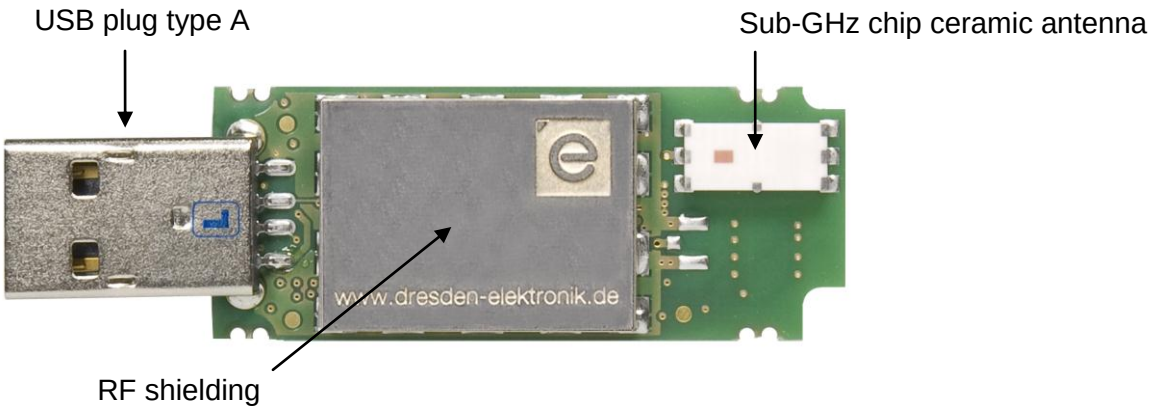


Figure 5: Top view deRFusb-13E00 JTAG

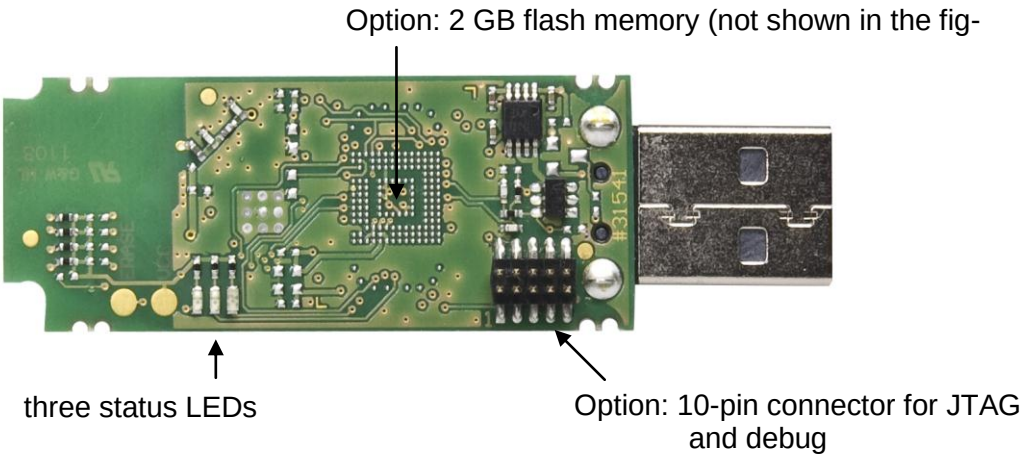


Figure 6: Bottom view deRFusb-13E00 JTAG

5. Technical data

Table 1: Mechanical data

Mechanical	
Radio module	
Size (length x width x height)	71.0 x 23.0 x 8.7 mm (in case)
	63.5 x 19.0 x 5.5 mm (without case)
	63.5 x 19.0 x 9.5 mm (with JTAG, without case)
Weight	13 g (in case)
Connectors	
USB	Plug type A
10-pin connector option ‘JTAG’	2 x 5 pins, 1.27 mm (50 mil) pitch

Table 2: Environment

Temperature and humidity					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
Operating temperature range	T_{work}	-20		+70	°C
Operating humidity range		25		80	% r.H.
Storage temperature range	$T_{storage}$	-40		+85	°C

Table 3: Electrical data

Electrical (Supply voltage VUSB = 5.0V)					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
Supply voltage	VUSB	4.5	5.0	5.5	V
Current consumption[1]	I_{TXon} (TX_PWR = 0x00)		51		mA
	I_{TXoff}		32		mA
	I_{RXon}		45		mA

[1] valid for deRFusb-23E00 / deRFusb-23E00 JTAG / deRFusb-13E00 / deRFusb-13E00 JTAG, see **Table 5** for current consumption of USB sticks with external flash memory

Table 4: Quartz crystal properties

Quartz crystal					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
MCU crystal	Frequency		18.432		MHz
	Frequency tolerance		+/- 30		ppm
	Load capacitance		16		pF
Transceiver crystal	Frequency		16.000		MHz
	Frequency tolerance		+/-10		ppm
	Load capacitance		9		pF

Table 5: External Flash option

External flash (Supply voltage VUSB = 5.0V)					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
Storage size[2]			2		GB
RW speed	Read/Burst Read Write/Burst Write		908 882 178 192		kB/s kB/s kB/s kB/s
Current consumption[3] (while MCU = Idle and TRX = Off)	Auto Sleep Sleep (CMD5) Read/Burst Read Write/Burst Write		32 32 53 58 87 88		mA mA mA mA mA mA

[2] 2 GB = 2000 MB = 2.000.000 kB

[3] valid for deRFusb-23E06 / deRFusb-23E06 JTAG / deRFusb-13E06 / deRFusb-13E06 JTAG

Table 6: Radio data of deRFusb-23E00/06/JTAG

Radio 2.4 GHz (Supply voltage VUSB = 5.0V)					
	Parameter / feature	*Min*	*Typ*	*Max*	*Unit*
Antenna	Type		Chip ceramic		
	Gain	-0.2	+0.5	+0.9	dBi (peak)
	Diversity		No		
Range[4]	Line of sight		>200	240	m
Frequency range[5]	PHY_CC_CCA = 0x0B...0x1A	2405		2480	MHz
Channels	PHY_CC_CCA = 0x0B...0x1A		16		
Transmitting power conducted	TX_PWR = 0x00	+2.8	+3.0	+3.6	dBm
Receiver sensitivity	Data Rate = 250kBit/s Data Rate = 500kBit/s Data Rate = 1000kBit/s Data Rate = 2000kBit/s		- 97 -93 -90 -89		dBm dBm dBm dBm
Data rate (gross)	TRX_CTRL_2 = 0x00 TRX_CTRL_2 = 0x01 TRX_CTRL_2 = 0x02 TRX_CTRL_2 = 0x03		250 500 1000 2000		kBit/s kBit/s kBit/s kBit/s

[4] Measured while device plugged into laptop standing on a tripod with a height of 1.4 meters above ground level and PER≤1%

[5] Operating the transmitter at channel 26 requires to ensure a duty cycle ≤29%

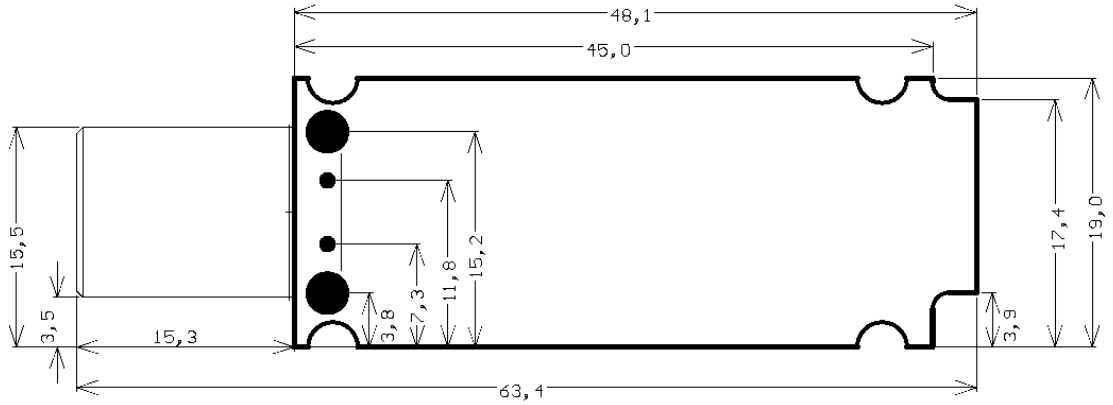
Table 7: Radio data of deRFusb-13E00/06/JTAG

Radio Sub-GHz (Supply voltage VUSB = 5.0V)					
	Parameter / feature	*Min*	*Typ*	*Max*	*Unit*
Antenna	Type		Chip ceramic		
	Gain		- 0.7		dBi (peak)
	Diversity		No		
Range[6]	Line of sight (915MHz) Line of sight (868MHz)		>100 >200	120 220	m m
Frequency range	PHY_CC_CCA = 0x00 PHY_CC_CCA = 0x01...0x0A	 906	868.3	 924	MHz MHz
Channels	PHY_CC_CCA = 0x00 PHY_CC_CCA = 0x01...0x0A		1 10		
Transmitting power conducted	TX_PWR = 0x00 @ 915MHz TX_PWR = 0x00 @ 868MHz			+ 9.0 + 5.0	dBm dBm
Receiver sensitivity	Data Rate = 20kBit/s Data Rate = 40kBit/s Data Rate = 250kBit/s		-106 -104 -97		dBm dBm dBm
Data rate (gross)	TRX_CTRL_2 = 0x00 TRX_CTRL_2 = 0x08 TRX_CTRL_2 = 0x09 TRX_CTRL_2 = 0x2A		20 100 200 400		kBit/s kBit/s kBit/s kBit/s
	TRX_CTRL_2 = 0x04 TRX_CTRL_2 = 0x0C TRX_CTRL_2 = 0x0D TRX_CTRL_2 = 0x2E		40 250 500 1000		kBit/s kBit/s kBit/s kBit/s

[6] Measured while device plugged into laptop standing on a tripod with a height of 1.4 meters above ground level and PER≤1%

6. Mechanical size

The outer PCB dimensions are the same and not depending on the different USB board options, for details refer to **Table 1**. The example shown in **Figure 7** is the deRFusb-13E00 / deRFusb-13E06 radio stick; placed in the case the mechanical size is 71.0 x 23.0 x 8.7 mm (L x W x H).



All dimensions are in millimeters.

Figure 7: Mechanical dimension top view

The 10-pin connector dimension is shown in **Figure 8** as part X2; the displayed antenna type is the 2.4 GHz USB stick one.

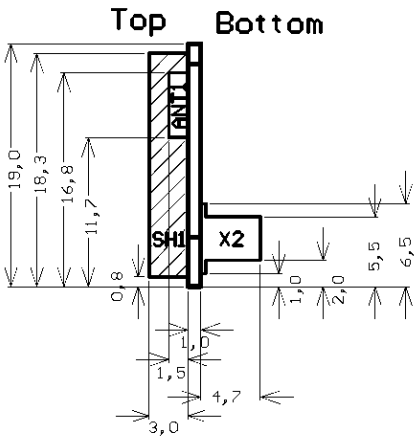


Figure 8: Mechanical dimension side view

7. Application environment

The USB sticks are designed to connect an IEEE 802.15.4 network with the PC and laptop environment. Today there are different variants of USB ports on laptop and PC devices. The USB stick dimension is optimized to plug other USB devices in adjacent ports especially in horizontal or vertical designed USB hubs.

Generally, the radiation pattern of RF devices depends on the placement and the application environment. The test measurement and certification process was done with a plugged USB stick on the side of an USB port of a laptop while the display was open. It is recommended to plug the USB stick sideways at an USB port of a laptop, if applicable. The use of application setups like USB hubs or USB extension cables may result in a lower transmit and receive range.

The USB stick can only be directly plugged into type A ports; into a laptop, PC or hub.

Figure 9: Laptop USB port type A

8. Pin assignment

The USB stick has a type A USB plug and an optional 10-pin connector in 1.27 mm pitch for programming via JTAG interface and tracing via UART. This connector is directly accessible from the USB stick bottom side, see **Figure 10**. The internal and external signal connection to the MCU and transceiver is shown in **Table 8**. The external available signals are described in **Table 9**.

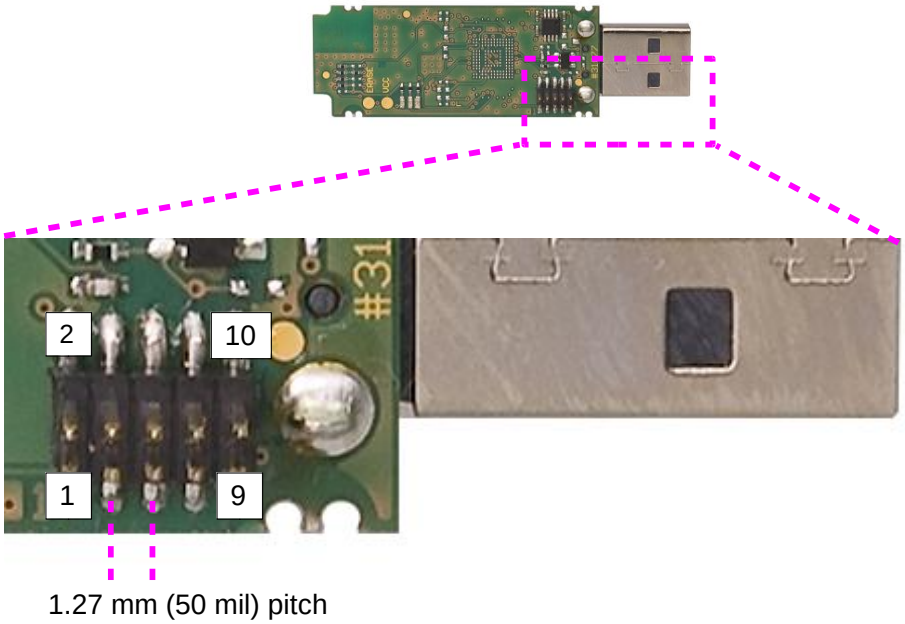


Figure 10: Pin assignment of optional 10-pin connector

Table 8: Pin assignment of deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG

µC Pin	Signal name	Function	Comments
USB connector			
56	DDM	USB DM	
57	DDP	USB DP	
10-pin connector (only available with option 'JTAG')			
53	PB7/TCK/SWCLK	JTAG TCK	Connector pin 1
-	GND		Connector pin 2
49	PB5/TWCK1/PWML0/WKUP13/TDO	JTAG TDO	Connector pin 3
-	VCC		Connector pin 4
51	PB6/TMS/SWDIO	JTAG TMS	Connector pin 5
39	NRST	/Reset	Connector pin 6
-	VCC		Connector pin 7
30	PA9/URXD0/NPCS1/PWMFI0	Debug RXD	Connector pin 8
33	PB4/TWD1/PWMH2/TDI	JTAG TDI	Connector pin 9
29	PA10/UTXD0/NPCS2	Debug TXD	Connector pin 10
Miscellaneous			
13	PA19/RK/PWML0/A15/AD2	LED1	red
9	PA17/TD/PCK1/PWMH3/AD0	LED2	yellow
10	PA18/RD/PCK2/A14/AD1	LED3	green
35	PA5/RXD0/NPCS3	Hardware ID1	
34	PA6/TXD0/PCK0	Hardware ID2	
32	PA7/RTS0/PWMH3/XIN32	Hardware ID3	
2 GB flash memory (only available with option '06')			
42	MCDA0	ext. Flash Data 0	
52	MCDA1	ext. Flash Data 1	
26	MCDA2	ext. Flash Data 2	
37	MCDA3	ext. Flash Data 3	
38	MCCDA	ext. Flash Command	
41	MCCK	ext. Flash Clock	
Erase pin			
55	PB12/PWML1/ERASE		See **Section 11**

Table 9: Signal description list

Signal name	Function	Type	Active level	Comments
Power - USB connector				
DDM	USB Full Speed Data –	Analog Digital		
DDP	USB Full Speed Data +			
JTAG				
TCK	Test Clock	Input		On-board Pull-up
TDI	Test Data In	Input		On-board Pull-up
TDO	Test Data Out	Output		
TDM	Test Mode Select	Input		On-board Pull-up
Reset				
RSTN	Microcontroller Reset	I/O	Low	Pull-Up resistor
UART0				
URXD0	UART Receive Data	Input		
UTXD0	UART Transmit Data	Output		

9. On-board transceiver

The main difference between the deRFusb-23E00/06/JTAG and the deRFusb-13E00/06/JTAG USB radio sticks is the built-in 2.4 GHz or alternatively Sub-GHz transceiver in combination with the appropriate on-board chip antenna. The signal connection between MCU and transceiver is shown in **Table 8**.

deRFusb-23E00/06/JTAG - AT86RF231 transceiver

The low-power 2.4 GHz transceiver is designed for industrial and consumer IEEE 802.15.4, ZigBee, RF4CE, ISA100.11a and high data rate ISM applications. For details refer to **[1]** in the reference section.

deRFusb-13E00/06/JTAG - AT86RF212 transceiver

The low-power, low-voltage 800/900MHz transceiver is designed for low-cost IEEE 802.15.4, ZigBee and high data rate ISM applications available Europe and North America. For details refer to **[2]**.

9.1. General transceiver description

These single-chip radio transceivers provide a complete radio transceiver interface between an antenna and a microcontroller.

They comprise the analog radio transceiver and the digital modulation and demodulation including time and frequency synchronization and data buffering. The number of external components is minimized such that only the antenna, the crystal and decoupling capacitors are required. The bidirectional differential antenna pins are used for transmission and reception, thus no external antenna switch is needed.

An internal 128 byte RAM for RX and TX buffers the data to be transmitted or the received data. Two on chip low dropout voltage regulators provide the internal analog and digital 1.8 V supply.

The transceivers further contain comprehensive hardware-MAC support (Extended Operating Mode) and a security engine (AES) to improve the overall system power efficiency and timing.

9.2. Internal transceiver connection to the MCU

The internal circuitry between MCU and transceiver is described in **Table 10**.

Table 10: Transceiver connection

µC Pin	TRX Pin	Signal name	Function	Comments
Internal transceiver interface				
20	10	PA15/TF/TIOA1/PWML3	RXTS/DIG2	1. Antenna Diversity RF switch control 2. RX Frame Time Stamping
11	11	PA21/RXD1/PCK1/AD8	SLP-TR	Controls sleep, transmit start, receive states
21	19	PA14/SPCK/PWMH3	SCK	SPI Serial Clock
27	20	PA12/MISO/PWMH1	MISO	Master In / Slave Out
22	22	PA13/MOSI/PWMH2	MOSI	Master Out / Slave In
28	23	PA11/NPCS0/PWMH0	SELN	SPI Select
47	24	PA1/PWMH1/TIOB0/A18	IRQ	1. Interrupt request signal 2. Frame Buffer Empty Indicator
23	8	PA24/RTS1/PWMH1/A20	RST	Transceiver Reset
36	17	PA4/TWCK0/TCLK0	CLKM	Master clock signal output, internal lowpass filter assembled

10. On-board components and peripherals

This section describes the important on-board peripherals: Clock, status LEDs as well as memory and access options to the board.

10.1. Clock

The USB sticks contain an external on-board 18.432 MHz 30 ppm quartz crystal for the MCU and a 16.000MHz 10ppm quartz crystal for the transceiver. For optimum RF timing characteristics it is necessary to use a low tolerance crystal. The crystal assignment on the PCB is shown in **Table 11**.

Table 11: Crystal assignment

µC Pin	TRX Pin	Signal name	Function	Comments
Clock				
61	-	PB8/XOUT	18.432MHz quartz crystal	MCU crystal
62	-	PB9/XIN		
-	26	XTAL1	16.000MHz quartz crystal	Transceiver crystal
-	25	XTAL2		

10.2. Programmable LEDs

The USB sticks are assembled with three colored LEDs which are free programmable. **Figure 11** shows the red, yellow and green status LEDs. They are located on the bottom side of the PCB. The internal connection between MCU and LED is listed in

Table 12.

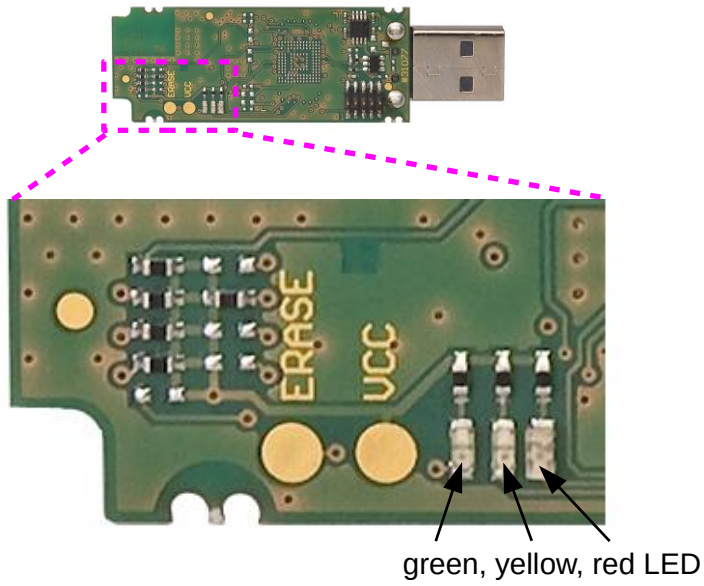


Figure 11: ERASE pins and status LEDs

Table 12: Internal connection of LEDs

µC Pin	Signal name	Function	Comments
LEDs			
13	PA19	LED1	red
9	PA17	LED2	yellow
10	PA18	LED3	green

10.3. ERASE and VCC pins

The ERASE pin (see **Figure 11**) is used to reinitialize the MCU flash content - and some of its NVM (Non-Volatile Memory) bits - to an erased state. The flash is transferred to its original state. For more details please refer to **[3]**.

To perform a flash erase operation the pin has to be tied high longer than 220 ms while the USB stick is connected to the PC.

Notes: By electrically connecting the two test points ERASE and VCC the internal MCU flash memory will be deleted. The firmware as originally available in the board's delivery condition (see **Section 12.2**) will be destroyed.

Caution: the USB sticks have the MAC address pre-flashed into the on chip Flash during the production process. Erasing the flash via the ERASE method will also erase this pre-flashed information which some firmware may require for proper operation. Please make sure your firmware will not be affected by the ERASE method before using it.
If you erased the pre-flashed information accidentally please read the 'User Manual deRFusb Firmware Update' **[3]** to recreate the MAC address information.

Work carefully when handling the board! The moisture of your fingers' skin may be sufficient under certain conditions to destroy the internal flash content.

10.4. On-board flash (option)

A 2 GB flash memory (iNand SDIN5D2-2G by Sandisk) to store user defined data is optionally available using the deRFusb-23E06/JTAG and deRFusb-13E06/JTAG USB radio sticks.

This flash memory is typically applied as mass storage device (MSD) for user data. It works like a Multimedia Card (MMC). Possible data bit modes are 1bit and 4bit.

The flash is equipped with a memory controller and has a NAND flash architecture. It complies with eMMC Specification Version 4.4.

The technical data of the assembled flash is listed in **Table 5**.

10.4.1. Mass Storage Device example

An example to use the flash as Mass Storage Device in Windows® can be found on the dresden elektronik webpage getting started documentation in section 'Native Examples'. The steps how to use the USB stick flash as MSD are described here. Currently the examples can only be run with the devices deRFusb-23E06 and deRFusb-13E06.

1. Following the programming instructions in **Section 11** and flash the device with the ‘deRF_MSD’ native example.
2. Plug in your device into PC or laptop.
3. A new hard disk drive will appear, see **Figure 12**.

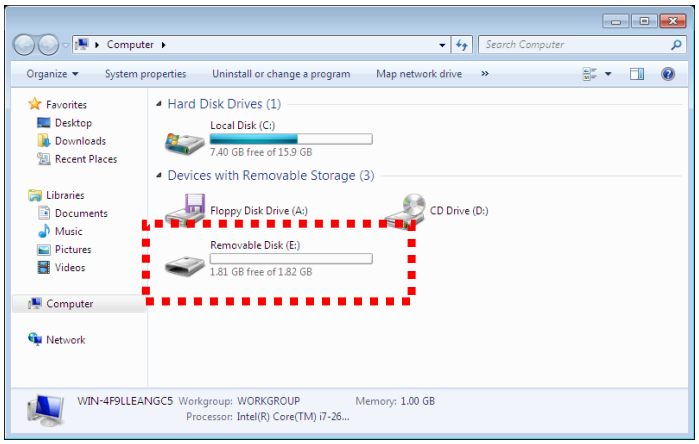


Figure 12: new HDD

4. The MSD should be formatted for proper work. Choose the FAT32 file system and, if necessary, a new volume name (**Figure 13**). The option ‘fast formatting’ is useful.

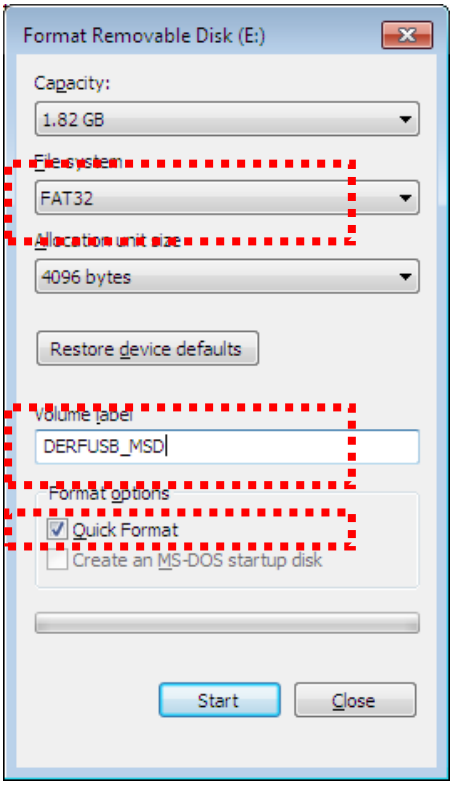


Figure 13: Formatting the MSD

5. Now the MSD will be displayed correctly with its volume name and the storage size (**Figure 14**).

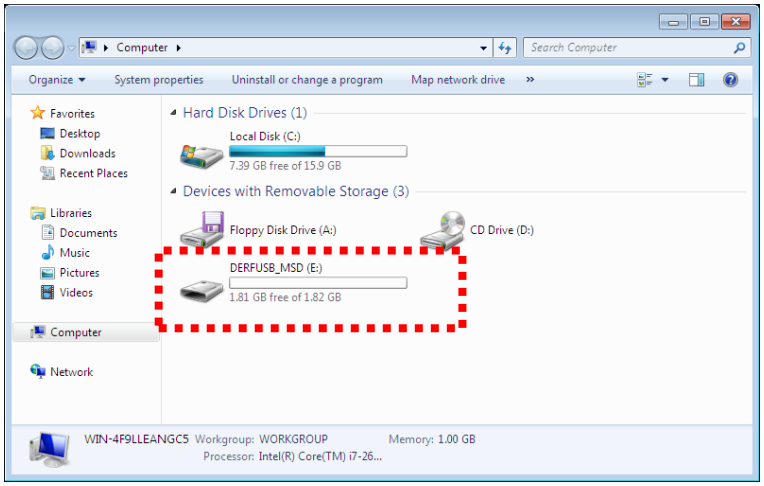


Figure 14: MSD with volume name and storage size

6. The MSD is ready for work. Data can be stored on the MSD.

10.5. Coaxial connector

The USB sticks have a footprint for assembling a coaxial connector to connect the device with an external antenna or for spectral measurements.

Attention: A coaxial connector is only applicable for test and measurement. CE conformity and FCC certification become invalid!

At first the couple capacitor has to be removed and placed to the shared footprint. It is possible to use the removed one. If a new capacitor is required use 22 pF package 0402[7] for 2.4 GHz applications and 100 pF package 0402 for Sub-GHz. Then place a 10 kOhms 0402 resistor on the appropriate footprint next to coaxial connector. At last place a U.FL coaxial connector, like U.FL-R-SMT-1(01) by Hirose. All soldering actions can be done by hand. The use of a forceps and a microscope are maybe useful.

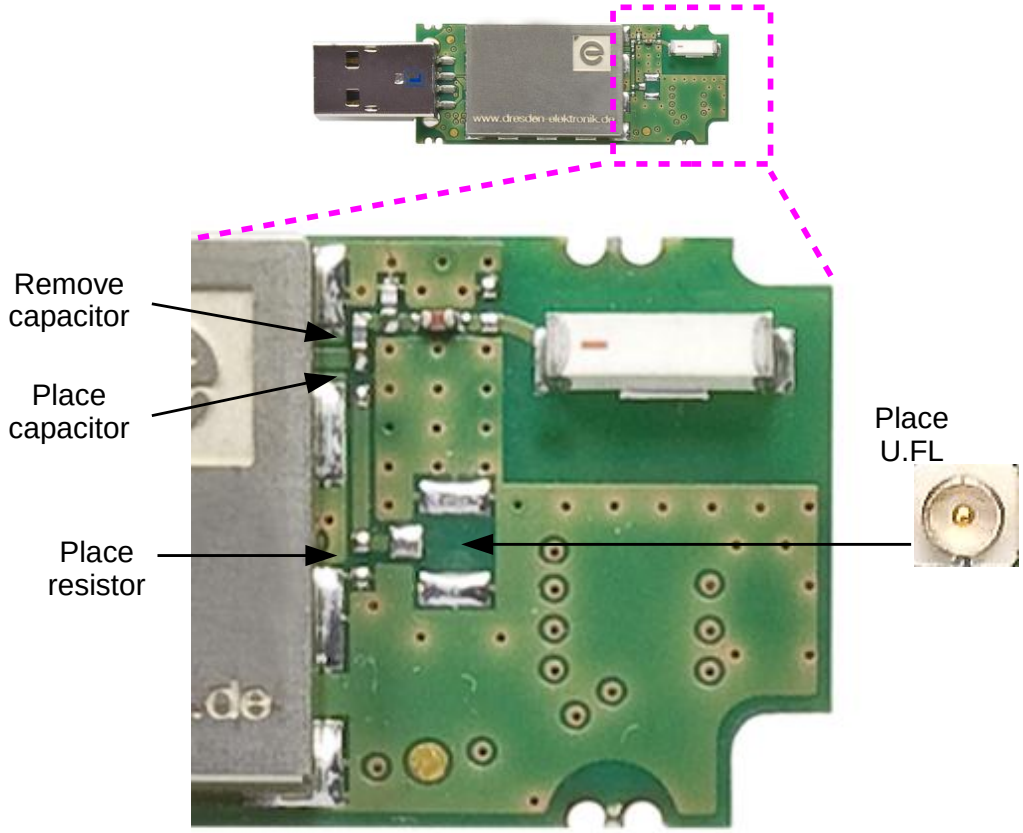


Figure 15: Footprint for U.FL coaxial connector

[7] Package 0402 (1005 metric) = 1.0 x 0.5 mm

11. Programming

The programming procedures are described in the documentation ‘User Manual deRFusb Firmware Update’ **[3]**, which is available as PDF document on dresden elektronik webpage. It describes step-by-step the update process of the USB sticks, the required software and hardware for programming via USB or JTAG and the driver installation on different operating systems.

12. Pre-flashed firmware

The USB sticks are available with different pre-flashed firmware depending on the hardware configuration. A colored marker is placed on the PCB for differentiation of the delivered firmware.

12.1. No firmware

These USB sticks have a red marker and will be delivered within a plastic enclosure. A custom firmware can be flashed via USB interface. See **Section 11** for more details.

12.2. Wireless UART firmware

USB sticks with pre-flashed wireless UART firmware have a light green marker and will be delivered with an attached plastic enclosure. Working with the wireless UART requires a terminal program like HyperTerminal or any other. The Wireless UART application example is described in **Section 12.3.1** for Windows and **Section 12.3.2** for Linux.

12.3. JTAG analyzer firmware (deRFusb-23E00 JTAG)

The analyzer version of the deRFusb23E00 JTAG USB radio stick is optimally matched for Perytons' professional network and protocol analysis software.

With the valid 30-day **Trial licence** you can monitor network structures as well as observe data flows and runtime performance in detail without additional effort. Especially during the development phase this protocol analysis software will serve as an essential and valuable tool. Compared to other analyzer tools the dresden elektronik USB radio stick facilitates synchronous sniffing of all 16 channels. The analyzer is operating with an accuracy of 1µs.

All three Perytons' software versions are supported for the 802.15.4 radio range:

Version	Description	Number of required USB sticks
Peryton-S	Single-channel analyzer	1
Peryton-D	Like S with antenna diversity	2
Peryton-M	Multi-channel analyzer	Channels + 1

12.3.1. Step-by-Step instructions for Windows

1. Plug in two USB sticks with pre-flashed wireless UART firmware into your PC(s) and/or laptop(s).
2. If you connect first time to a PC, you will be asked to install the driver for the USB device. The USB drivers are available on dresden elektronik homepage. Refer to the products web shop site.
3. The Windows device manager tells you which virtual COM port (serial port) is assigned to each USB stick.
4. If you know both COM ports, then open two terminal program sessions.
5. On each terminal session you have to set up the corresponding COM port. Baud rate, data bits, parity and stop bit settings are unimportant.
6. If all is set up correctly, simply type any character into one terminal window and you can see this character on the other terminal window (this also runs vice versa).
7. The character is received by the USB stick and transferred wireless to the other USB stick, that sends the received character to the own terminal program, see **Figure 16**.

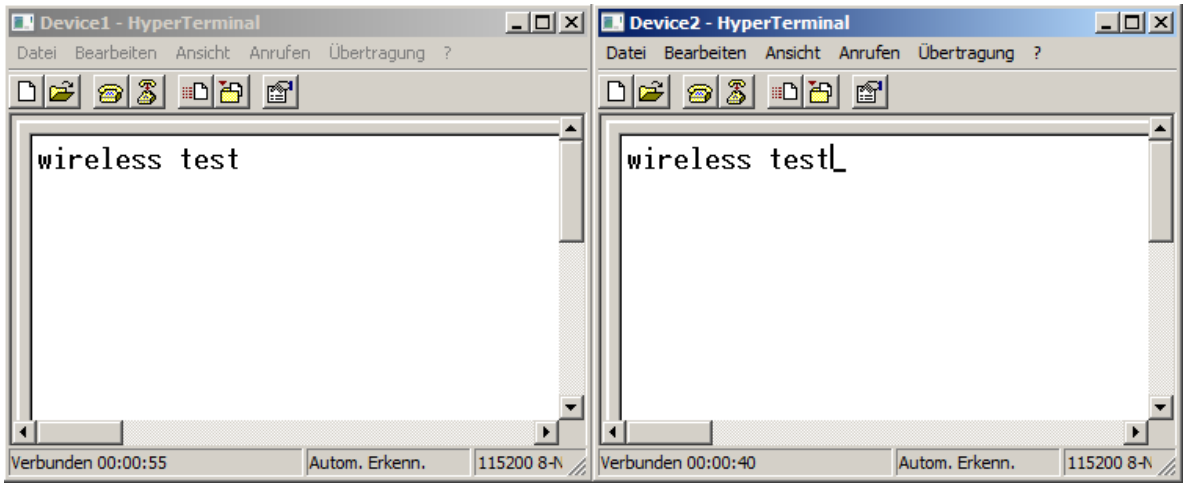


Figure 16: Wireless UART terminal session

12.3.2. Step-by-Step instructions for Linux

In order to use the serial USB port of deRFusb products with Linux the following steps have to be carried out. The user is either required to have root privileges or use sudo.

1. Use the following commands to unload the relevant kernel modules:
   rmmod usbserial
2. Create and open the file */etc/modprobe.d/dresden_elektronik.conf*. If the directory */etc/modprobe.d/* doesn't exist edit the file */etc/modprobe.conf* or */etc/modprobe.conf.local* instead.

   Currently it is not possible to have multiple device types running at the same time. The limit is one device for ftdi_sio and one for usbserial module.
   All devices will be included in the mainline kernel and lift this limitation. The applicable kernel version is not yet known.

   Add the following lines to the file:

   #deRFusb23E00
   #options usbserial vendor=0x1cf1 product=0x001a
   #deRFusb13E00
   #options usbserial vendor=0x1cf1 product=0x001b
   #deRFusb13E06
   #options usbserial vendor=0x1cf1 product=0x0027
   #deRFusb23E06
   #options usbserial vendor=0x1cf1 product=0x0025

3. Uncomment the options line for your device. This is also valid for USB sticks with JTAG connector. Example for a deRFusb:
   #deRFusb23E00
   options usbserial vendor=0x1cf1 product=0x001a
4. Reload the kernel modules unloaded in Step 1
   modprobe usbserial
5. After connecting the device to PC or laptop USB port a new device should appear in the directory /dev. The device name is either */dev/ttyUSBx* or */dev/ACMx* there x is a number from 0-9.
6. Open two terminal program sessions for the devices.
7. If all is set up correctly, simply type any character into one terminal and you can see this character on the other terminal (this also works vice versa).
8. The character is received by the USB stick and transferred over air to the other USB stick, who sends the received character to the own terminal program.

13. Radio certification

13.1. United States (FCC)

The deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG USB radio sticks comply with the requirements of FCC part 15 B and part 15 C.

The FCC certification for deRFusb-13E00/06/JTAG is pending.

To fulfill FCC Certification requirements, an OEM manufacturer must comply with the following regulations:

The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, the outside of the device into which the module is installed must also display a label referring to the enclosed module.

This exterior label can use wording such as the following. Any similar wording that expresses the same meaning may be used.

Sample label for USB radio stick deRFusb-23E00, deRFusb-23E06, deRFusb-23E00 JTAG and deRFusb-23E06 JTAG:

FCC-ID: XVV-ARM323E00
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: The deRFusb-23E00 JTAG, deRFusb-23E06 and deRFusb-23E06 JTAG USB radio sticks fulfill a Permissive Change Class 1 regarding to FCC Section 2.1043 and complies with the requirements of FCC part 15.

The Original Equipment Manufacturer (OEM) must ensure that the OEM modular transmitter is labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment.

This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation (FCC 15.19). The internal / external antenna(s) used for this mobile transmitter must provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter.

Installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance. This device is approved as a mobile device with respect to RF exposure compliance, and may only be marketed to OEM installers. Use in portable exposure conditions (FCC 2.1093) requires separate equipment authorization.

Modifications not expressly approved by this company could void the user's authority to operate this equipment (FCC section 15.21).

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Channel 26 issue

The built in transceiver AT86RF231 has an issue considering the transmitted power in the last channel 26. Because of the restricted band in United States that starts at 2483.5 MHz the limit for spurious emissions are stricter. The best solution to fulfill the FCC requirements is to set a maximum duty cycle of 29% for channel 26. This value is related to a 100ms period, which means that the transceiver can transmit 29ms within a period of 100ms. This leads to a correction factor according to ANSI C63.10-2009 (clause 4.4) that decrease the measured transmit value below the limit and to provide a FCC conform application.

13.2. European Union (ETSI)

The deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG USB radio sticks have been tested compliant for use in the European Union countries according to EN300328-V1.7.1 and EN301489-1-V1.8.1.

If the deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG USB radio sticks are incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive.

The manufacturer must maintain a copy of the deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG USB radio sticks documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

The “CE“ marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials "CE" taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the above graduated drawing must be respected.
- The CE marking must have a height of at least 5mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

More detailed information about CE marking requirements you can find at "DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" on 9 March 1999 at section 12.

14. Ordering information

The product name includes the following information:

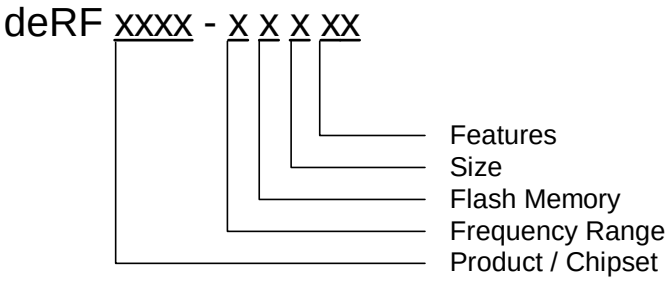


Table 13: Product name code

Product name code			
Information	*Code*	*Explanation*	*Comments*
Product / Chipset	usb	USB radio stick	
Frequency range	1	868/915 MHz	
	2	2.4 GHz	
Flash memory	3	256 kB	
Size	E	USB stick	
Features	00	chip antenna	On-board
	06	chip antenna, 2 GB flash	On-board
	00 JTAG	chip antenna 10-pin connector	JTAG + DEBUG
	06 JTAG	chip antenna, 2 GB flash 10-pin connector	JTAG + DEBUG

Table 14: Ordering information

Ordering information		
Part number	*Product name*	*Comments*
BN-031805	deRFusb-23E00 NO FW	USB radio stick for 2.4 GHz delivered with a fitting case no pre-flashed firmware
BN-033202	deRFusb-23E00 JTAG WUART FW	USB radio stick for 2.4 GHz with assembled JTAG connector pre-flashed with Wireless UART firmware
BN-031075	deRFusb-23E06 NO FW	USB radio stick for 2.4 GHz with 2 GB flash delivered with a fitting case no pre-flashed firmware
BN-033203	deRFusb-23E06 JTAG WUART FW	USB radio stick for 2.4 GHz with 2 GB flash with assembled JTAG connector pre-flashed with Wireless UART firmware
BN-031807	deRFusb-13E00 NO FW	USB radio stick for Sub-GHz delivered with a fitting case no pre-flashed firmware
BN-033206	deRFusb-13E00 JTAG WUART FW	USB radio stick for Sub-GHz with assembled JTAG connector pre-flashed with Wireless UART firmware
BN-031539	deRFusb-13E06 NO FW	USB radio stick for Sub-GHz with 2 GB flash delivered with a fitting case no pre-flashed firmware
BN-033207	deRFusb-13E06 JTAG WUART FW	USB radio stick for Sub-GHz with 2 GB flash with assembled JTAG connector pre-flashed with Wireless UART firmware
BN-028337	SAM-ICE-Adapter	program and debug interface adapter for USB radio sticks

15. Revision notes

Although the boards provide a CLKM connection from the radio transceiver to the micro controller, this connection is rarely used by any firmware. From performance measurements on the 2.4 GHz USB sticks deRFusb-23E00/06/JTAG this CLKM connection has a slight influence on the packet error rate in channel 26 resulting in less range and a higher packet error rate in general on this channel. Therefore we strongly recommend all users to check their firmware settings and ensure that the CLKM signal from the transceiver will be disabled in all situations.

Up to now no other technical problems, malfunctions or critical issues are not known for the deRFusb-23E00/06/JTAG and deRFusb-13E00/06/JTAG USB radio sticks.

16. References

[1] AT86RF212-ZU: AVR Low Power 700/800/900 MHz Transceiver for IEEE802.15.4-2006, IEEE802.15.4-2009, ZigBee, 6LoWPAN, and ISM Applications; Datasheet; 8186-MCU Wireless-02/10

[2] AT86RF231-ZU: AVR Low Power 2.4 GHz Transceiver for ZigBee, IEEE802.15.4, 6LoWPAN, RF4CE, SP100, WirelessHART, and ISM Applications; Datasheet; 8111C-MCU Wireless-09/09

[3] User Manual deRFusb Firmware Update, Version 1.3; 06/2012, http://www.dresden-elektronik.de

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